



# Using the NMRA Curved Track Center and Obstacle Clearance Assistant

Author(s): Van S. Fehr

NMRA Recommended Practices
RP-7.6
July 2017
© 2017 NMRA

## Introduction

NMRA RP-7.1 **Tangent Track Centers and Clearance Diagrams** defines clearances that ensure proper clearance around rolling stock (cars and locomotives) operating on tangent (straight) track only. As NMRA RP-7.1 states, operating rolling stock on a curved track requires special track center and clearance considerations.

The reason for special consideration is that on a single curved track, and on adjacent concentric curved tracks, the track centerline spacing, track radius, and pertinent rolling stock dimensions (described later), all reduce the actual clearance between equipment on adjacent tracks and between nearby obstacles. To ensure that minimum acceptable clearance is not compromised requires additional track centerline spacing and obstacle clearance.

NMRA TN-7 **Curved Track Centerline and Obstacle Clearance Calculation Methodology**, also posted under **Standards and Conformance** on the **NMRA Website**, fully documents the engineering equations developed for that purpose. NMRA RP-7.2, RP-7.3 and RP-7.4 tabulate the results from those equations for a worst-case set of equipment in each modeling era, for interurban equipment, and for several specified track radii. Most modelers will find those tables, and their accompanying instructions, sufficient for their layout planning and construction purposes.

However, modelers who may wish more specific results for equipment and trackwork choices of their own, and/or the optional use of superelevation, will have to make their own calculations to ensure safe operation. Those calculations may seem daunting, but the NMRA provides a companion computer program, an “app,” that makes them for you.

The app is the **NMRA Curved Track Center and Obstacle Clearance Assistant** (henceforth the **Assistant**). It is simple to use, and operates on almost any device having internet access. In addition to curved track centers and obstacle clearance, the **Assistant** also calculates the increased clearance and tunnel diagram dimensions necessary for curved track, as NMRA RP-7.5 describes.

## The Assistant

You will find the **Assistant** posted on the **NMRA Website**. In the **Standards** pull-down menu, select **Standards and Recommended Practices**, and scroll down to this document (NMRA RP-7.6). The **Assistant** is posted right next to it. Click or tap **Assistant**, and the screen you see in **Figure 1** will open for use in your internet browser (e.g., Internet Explorer, Edge, Chrome, Mozilla, etc.).

The screen consists of three sections: The first is a list of simplified instructions. The second section is a set of yellow and blue boxes in which you enter required information. The third is a set of green boxes that display the calculated results.

There are also two orange buttons, one labeled **INPUT EXAMPLE** and the other **CALCULATE**. When you click (or tap) the **INPUT EXAMPLE** button, the **Assistant** will fill all the input boxes as the top part of **Figure 2** illustrates. When you click (or tap) the **CALCULATE** button, the app makes the necessary calculations and displays the results in the green boxes as the lower part of **Figure 2** illustrates.

The yellow boxes require numerical information specified in decimal format. The calculations are independent of modeling scale, so you may use any measurement units you like, as long as they are all the same. For example, you may use all feet, or all inches, but may not mix feet and inches. You may use all millimeters, or all meters, but may not mix them. The calculated results are displayed in the same measurement units as the input information.

# NMRA CURVED TRACK CENTER AND OBSTACLE CLEARANCE ASSISTANT

Author: Van S. Fehr

Version: 1.0 Date: July 2017

Copyright: July 2017 National Model Railroad Association

Instructions: (these are reminders - see NMRA 7.6 for detailed instructions)

1. Enter all input values in the yellow and blue boxes. Click or tap **INPUT EXAMPLE** to enter an example.
2. Yellow boxes require decimal numbers in the **same** units (inches, feet, millimeters, etc.).
3. Blue boxes require text (numbers and mixed-case letters).
4. **Output Units Format:** Enter **D** for **decimal** output (any units), or **F** for **fractional** output (inches only).
5. Click or tap **CALCULATE** to display results in the green boxes.

**INPUT EXAMPLE** Click or tap to fill input boxes with an example.

## TRACK PARAMETERS

Tangent Track Centers	
Tangent Obstacle Clearance	
Curve Radius (inner)	
Superelevation	
Track Gauge	
Output Units Format	

## CLEARANCE DIAGRAM

(from RP-7.1)

Dimension A	
Dimension B	
Dimension G	
Dimension P	
Dimension Rc	

## EQUIPMENT ENVELOPES

### Equipment 1

Type	
End Distance A	
Pivot Distance	
End Distance B	
Height	

### Equipment 2

Type	
End Distance A	
Pivot Distance	
End Distance B	
Height	

**CALCULATE** Click or tap to see results.

Curved Track Center

for SINGLE-TRACK

Outer Curve Radius

for DOUBLE-TRACK

## OBSTACLE CLEARANCES

Inside Obstacle Clearance	
Outside Obstacle Clearance	

Inner Obstacle Clearance	
Outer Obstacle Clearance	

## CLEARANCE DIMENSIONS

Dimension Aw	
Dimension Bw	
Dimension Gw	
Dimension Pw	

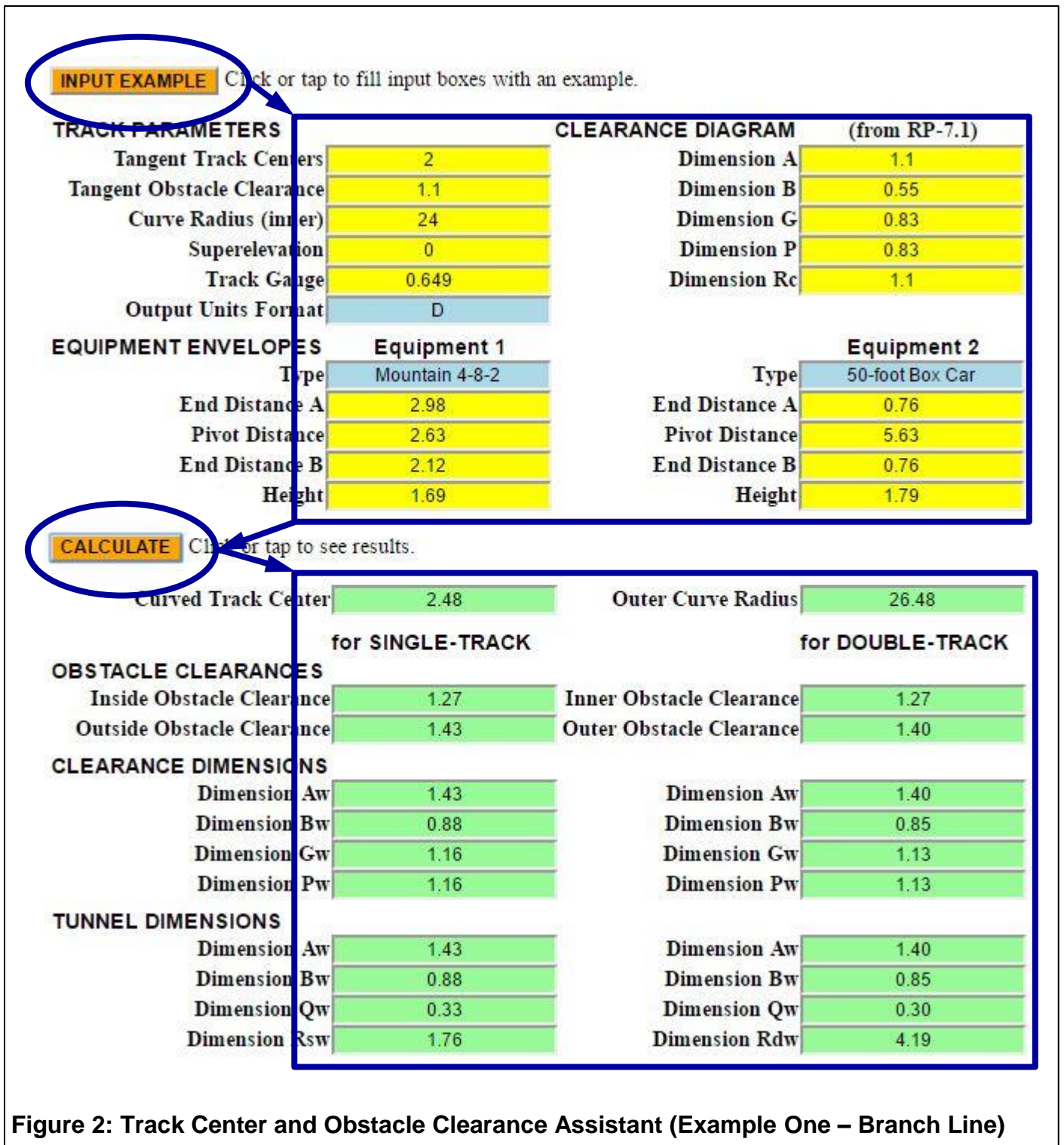
Dimension Aw	
Dimension Bw	
Dimension Gw	
Dimension Pw	

## TUNNEL DIMENSIONS

Dimension Aw	
Dimension Bw	
Dimension Qw	
Dimension Rsw	

Dimension Aw	
Dimension Bw	
Dimension Qw	
Dimension Rdw	

Figure 1: Curved Track Center and Obstacle Clearance Assistant Screen



**Figure 2: Track Center and Obstacle Clearance Assistant (Example One – Branch Line)**

The blue boxes require text information, as the input example shows in the equipment **Type** boxes. You may control the format of the calculated results using the **Output Units Format** entry. Enter a **D** to display results in decimal format with two decimal places. The entry is not case sensitive, so you may use an upper or lower case letter. Decimal format may be used for any measurement units. When you use inches, you may enter an **F** to display results in fractional format, rounded to the nearest 1/32 inch, as Figure 3 illustrates. Fractional format applies only to inches. Using it for other measurement units has no useful meaning. The **INPUT EXAMPLE** information that Figure 2 and Figure 3 shows is the same input information for the examples that follow later.

**INPUT EXAMPLE** Click or tap to fill input boxes with an example.

**TRACK PARAMETERS**

Tangent Track Centers	2
Tangent Obstacle Clearance	1.1
Curve Radius (inner)	24
Superelevation	0
Track Gauge	6.616
Output Units Format	F

**CLEARANCE DIAGRAM**

(from RP-7.1)

Dimension A	1.1
Dimension B	0.55
Dimension G	0.83
Dimension P	0.83
Dimension Rc	1.1

**EQUIPMENT ENVELOPES**

**Equipment 1**

Type	Mountain 4-8-2
End Distance A	2.98
Pivot Distance	2.63
End Distance B	2.12
Height	1.69

**Equipment 2**

Type	50-foot Box Car
End Distance A	0.76
Pivot Distance	5.63
End Distance B	0.76
Height	1.79

**CALCULATE** Click or tap to see results.

Curved Track Center	2 15/32	Outer Curve Radius	26 15/32
<b>for SINGLE-TRACK</b>		<b>for DOUBLE-TRACK</b>	
<b>OBSTACLE CLEARANCES</b>			
Inside Obstacle Clearance	1 9/32	Inner Obstacle Clearance	1 9/32
Outside Obstacle Clearance	1 7/16	Outer Obstacle Clearance	1 13/32
<b>CLEARANCE DIMENSIONS</b>			
Dimension Aw	1 7/16	Dimension Aw	1 13/32
Dimension Bw	7/8	Dimension Bw	27/32
Dimension Gw	1 5/32	Dimension Gw	1 1/8
Dimension Pw	1 5/32	Dimension Pw	1 1/8
<b>TUNNEL DIMENSIONS</b>			
Dimension Aw	1 7/16	Dimension Aw	1 13/32
Dimension Bw	7/8	Dimension Bw	27/32
Dimension Qw	11/32	Dimension Qw	5/16
Dimension Rsw	1 3/4	Dimension Rdw	4 3/16

**Figure 3: Track Center and Obstacle Clearance Assistant (Fractional Results)**

The results section follows below the **CALCULATE** button. The required **Curved Track Center** distance and the **Outer Curve Radius** appear immediately below. After that are the curved track **OBSTACLE CLEARANCES**, **CLEARANCE DIMENSIONS**, and **TUNNEL DIMENSIONS**. The first column of green boxes shows results for a **Single-Track** curve, and the second for a **Double-Track** curve.

**Setting Curved Track Centers and Obstacle Clearances**

To establish proper curved track centers and obstacle clearances for your specific situations, take the following three steps:

**Step 1:** Set your minimum **Tangent Track Center**, **Tangent Obstacle Clearance**, and other dimensions

**Step 2:** Determine which of your rolling stock equipment is limiting

**Step 3:** Use the **Assistant** to calculate the required track centers and obstacle clearances

The first two steps describe how to prepare input for the **Assistant**. These steps are straightforward, but the second takes some explanation. The third step is easily accomplished by running the **Assistant**, and uses two examples that demonstrate its use. The sections that follow describe these three steps in detail.

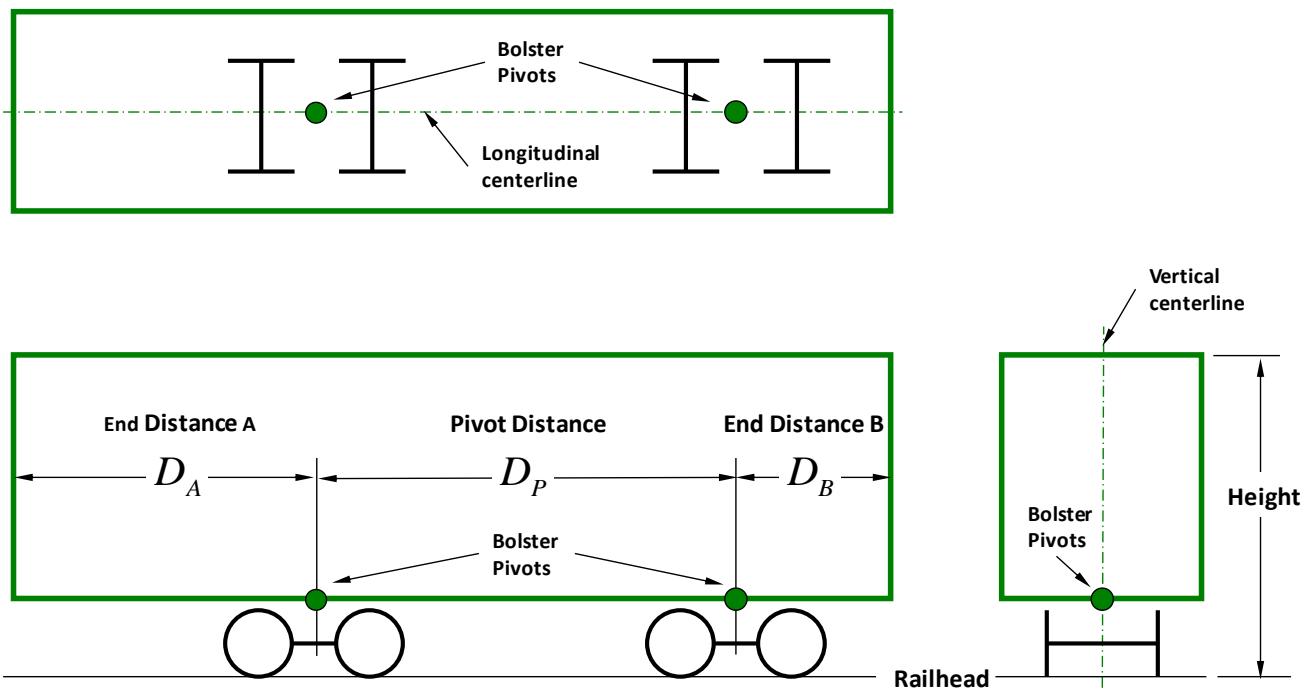
### STEP 1: Set Minimum Tangent Track Center and Obstacle Clearance

To ensure safe and unobstructed operation you must first establish your minimum **Tangent Track Center** spacing and your minimum **Tangent Obstacle Clearance**. For good results, the NMRA recommends those defined in **NMRA RP-7.1**. For scaling to modeling scales not listed, prototype dimensions appear in the first row of the tables in **RP-7.1**. For minimum **Tangent Obstacle Clearance**, the NMRA recommends using dimension **A** from **RP-7.1**.

You may select any minimum values you desire. Using values larger than the recommended minimums is always acceptable, e.g., allowing extra space for fingers when handling equipment. Be aware that if your minimums become too large, they may begin to limit the space available for other modeling uses. Using smaller minimum values is neither recommended nor prohibited, but, use caution when doing so.

Set your desired **Curve Radius**. This is the radius of a single curve, or the inner radius of two concentric curves. Set the amount of **Superelevation**, making sure to use the same units as all other input. Enter the **Track Gauge** as well. You should use the minimum **Track Gauge** specified in **NMRA Standard S-1.1, S-1.2** or **S-1.3**, for your modeling scale. Also decide which **Output Unit Format** you like, decimal (**D**) or fractional (**F**).

For later calculation of the modified clearance and tunnel dimensions, select the tangent track clearance diagram dimensions **A, B, G, P,** and **Rc** defined in **NMRA RP-7.1** for your modeling scale and era. To be consistent, you should use the same value for dimension **A** that you entered for the **Tangent Obstacle Clearance**. All of the modified clearance and tunnel dimensions depend on this value.



**Figure 4: Typical Freight, Passenger and Diesel Equipment Envelope (no scale)**

## STEP 2: Determine Limiting Equipment

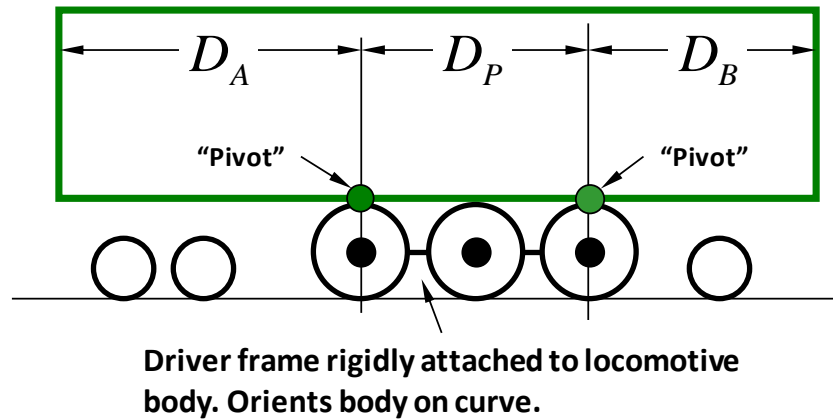
As mentioned above, curved track centers and obstacle clearance depends in part on rolling stock equipment dimensions. Of all the equipment in the roster you operate (or want to), there are only two specific equipment types that affect track center and obstacle clearance. In this step, you determine which ones they are.

### Equipment Envelope

All types of rolling stock fit inside a rectangular box-shaped *equipment envelope* that Figure 4 illustrates. For equipment on hand, you can easily measure the dimensions shown using a standard ruler or scale. You will need some kind of dimensioned reference drawing to determine dimensions for equipment that is not on hand. As shown, Figure 4 applies to any typical freight car, passenger car, or diesel locomotive. A curved track centerline passes directly under the bolster pivots. Thus, the line between the bolsters is a chord of the curve, and orients the body on it.

Perhaps not obvious is that a steam engine also uses the same box-shaped equipment envelope. The upper diagram in Figure 5 shows a typical steam locomotive whose “pivot” distance is the distance between the axles of the outermost driving wheels. These “pivots” orient the locomotive body on the curve because the curve centerline passes under the midpoints of the outermost driver axles.

### Typical Steam Loco



### Typical Articulated Steam Loco

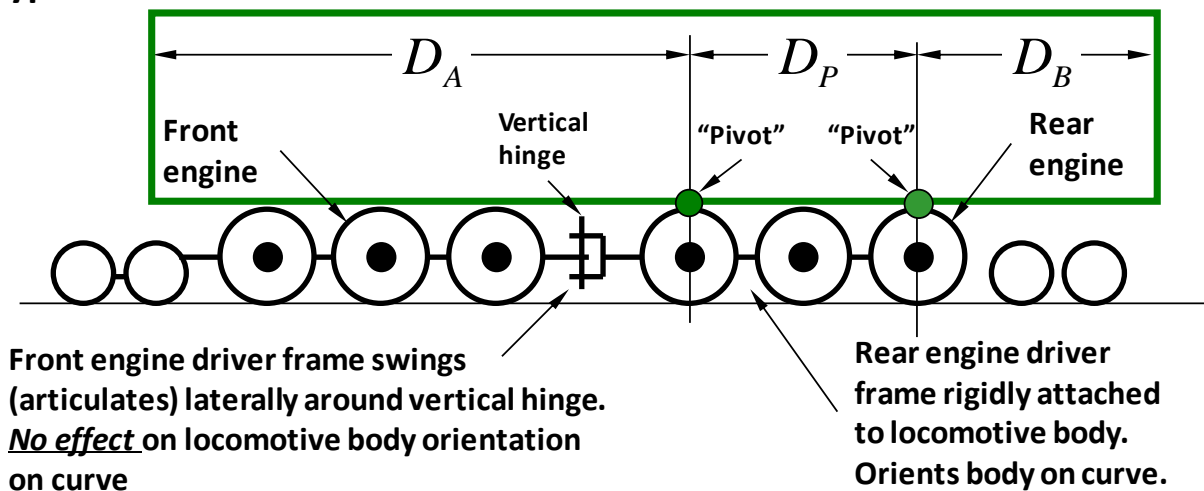


Figure 5: Typical Steam Locomotive Equipment Envelopes (no scale)

A typical articulated steam locomotive, shown in the lower diagram of **Figure 5**, is a special case. Many brass articulated locomotive models are faithful to the prototype. The rear engine frame is rigidly attached to the boiler, and the front engine frame swings laterally (articulates) around a vertical “hinge” on the front of the rear engine frame. Because the front engine swings somewhat like a leading truck, only the rear engine orients the locomotive on a curve. In this case, the “pivot” distance is the distance between the axles of the outermost drivers on the rear engine. An exception is the SP Cab Forward, on which the front engine is rigidly mounted, and the rear engine articulates.

Not all articulated steam locomotive models, especially the newer plastic or hybrid varieties, are faithful to the prototype “hinge” arrangement. To allow operation on tighter curves, model manufacturers sometimes mount each engine on its own bolster. This makes each engine operate like a truck on a diesel locomotive, or on a freight or passenger car. In this case, the pivot distance is the distance between the bolsters.

You should use some judgment when establishing the equipment envelope end distances **A** and **B**. Cab-unit diesels, some streamlined steam locos, and some passenger observation cars have rounded front ends and/or “boat tail” rear ends that curve away from sides that are nominally parallel to the rails. In this case, use the distance to end of the parallel side as the end distance. Ordinary steam locos, hood-unit diesels, box cabs, and ordinary passenger cars have easily identified corners.

Make a similar judgement for equipment height where equipment roofs slant or curve away from the otherwise vertical sides. For steam engines, the circular cross-section boiler makes height selection a little trickier. The height, important when using superelevated curves, may be at a side walkway or the roof line above a cab side-window.

### **Limiting Equipment**

On curved track, the equipment side on the inside of the curve extends inward from the track centerline more than it does on tangent track. Similarly, the equipment end corners extend further outward from the centerline. In combination, these two factors are the reasons why track centers and obstacle clearance must be increased on curved track.

It turns out that your equipment type having the longest pivot distance, and another type having the longest end distance, establish the limiting case that determines the required curved track centers and obstacle clearance for your railroad. Of all the equipment in your roster, visual inspection likely determines which two types are limiting. If not, taking a few measurements will quickly identify them. By measurement, or from a drawing, determine the equipment envelope dimensions in **Figure 4** or **Figure 5** for each. It is possible, although unlikely, that one equipment type will have both the longest pivot distance and the longest end distance.

Once you have the envelope dimensions for your limiting equipment, you are ready for Step 3.

### **STEP 3. Calculate Track Center and Obstacle Clearance**

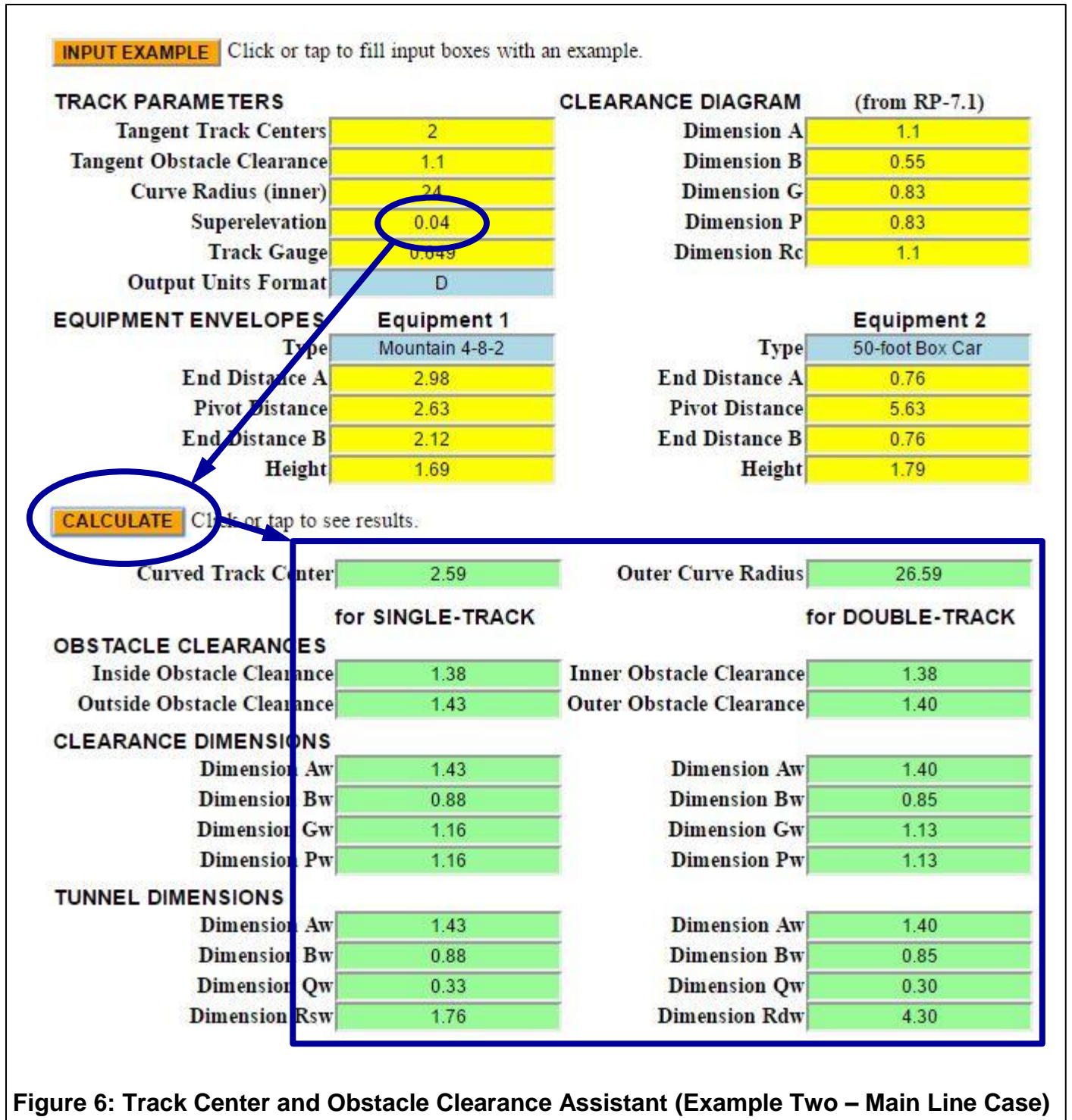
Before going further, note that superelevation affects curved track center and obstacle clearance. Superelevation is the amount the outer rail extends above the inner rail, banking the curve. Superelevation is not required in model railroading, but many modelers use it for its visual effect. If you use it, the **Assistant** takes the effect of superelevation into account.

Establishing curved track centers, obstacle clearances, and increased clearance diagram dimensions is best described by two simple examples. By working through these two examples in detail you will quickly see how easy the **Assistant** is to use. They are not extreme cases, but they illustrate the need for increased curved track center and obstacle clearance well.

In these examples, you model the Classic era in HO scale. In **Step 1**, you decide to use a minimum **Tangent Track Center** of 2.0 inches, slightly wider than the recommended value of 1.79 inches (13 prototype feet) in **NMRA RP-7.1** (a lot of HO modelers use this simpler value). You accept the recommendation for minimum **Tangent Obstacle Clearance** of 1.1 inches (Classic era, HO Scale, dimension **A** in **NMRA RP-7.1**). From **NMRA S-1.2**, the **Track Gauge** is 0.649 inches (the minimum value). The other **CLEARANCE DIAGRAMS** dimensions, **B**, **G**, **P**, and **Rc**, also come directly from **NMRA RP-7.1**.

In **Step 2**, you make a visual inspection of your roster. It quickly reveals that your 50-foot box cars have the longest pivot distance, and your Mountain 4-8-2 steam locomotive has the longest end distance. You make careful measurements of the dimensions shown in Figure 4 and Figure 5, and get these HO scale values in inches:

<u>Dimensions</u>	<u>Mountain 4-8-2</u>	<u>50-foot Box Car</u>
End Distance A	2.98	0.76
Pivot Distance	2.63	5.63
End Distance B	2.12	0.76
Height	1.69	1.79





These are the same dimensions you see in Figure 2, so you don't need to reenter them if you've clicked the **INPUT EXAMPLE** button. It does not matter which equipment type you select as **Equipment 1** or **Equipment 2**. It also does not matter if **End Distance A** or **End Distance B** is the larger. The program will determine which end has the longer end distance on each. Where only one type of equipment is limiting (unusual, but possible), you would enter the same dimensions for both **Equipment 1** and **Equipment 2**.

In **Step 3**, you want to look at two scenarios. The first is a single-track curve having a radius of 24 inches, located on a branch line. Trains run slowly on this branch so you decide to use no superelevation.

The second scenario is a fast, double-track mainline, whose inner track radius is also 24 inches. Because it looks impressive, you decide to use about 3½ prototype inches of superelevation, or about 0.04 inches in HO scale, on both tracks.

The curves in each scenario also pass through tunnels.

### Example One – Branch Line Scenario

The upper part of Figure 2 shows the input for this scenario. Notice **Superelevation** has an input value of zero. You click (or tap) the **CALCULATE** button and the results appear as shown in the bottom of Figure 2.

First notice the **Curved Track Center** and **Outer Curve Radius** values (2.48 and 26.48, respectively). While not needed for a single-track curve, they are used for the double-track mainline described in Example Two.

When constructing the 24-inch radius curve, you make sure that you place all trackside objects no closer to the curve centerline than the calculated **Inner Obstacle Clearance** and **Outer Obstacle Clearance** (1.27 and 1.43 inches, respectively). This ensures safe operation for equipment operating on the single-track curve.

Notice the **CLEARANCE DIMENSIONS** and **TUNNEL DIMENSIONS** results. For both, the dimension **Aw** is the same as the **Outside Obstacle Clearance** for the **SINGLE-TRACK**. That's because tunnel bores and portals are designed such that the tunnel centerline and track centerline are coincident. The **Assistant** (and the prototype) uses the larger of the **Inside Obstacle Clearance** and **Outside Obstacle Clearance** values (1.43) to set dimension **Aw**. The **Double-Track** results, although correct, do not apply to the single-track scenario.

### Example Two – Main Line Scenario

The upper part of Figure 6 shows the input for this scenario. Notice **Superelevation** now has an input value of 0.04. This is the only input difference between **Example One** and **Example Two**. You click (or tap) the **CALCULATE** button and the results appear as shown in the bottom of Figure 6. Only the **Double-Track** results apply to this scenario. The presence of superelevation has caused some subtle, but important differences.

As expected, the **Curved Track Center** and **Outer Curve Radius** have both increased compared to the no-superelevation case (2.59 and 26.59). The **Inner Obstacle Clearance** has increased from 1.27 to 1.38, a direct result of superelevation. You may notice that dimension **Aw** is slightly less than that of the **Single-Track** scenario. That's because **Aw** is now set by the limiting equipment being on the outer curve radius. Because the outer radius is larger, the outside clearance is a little less.